Express Mail No.: EV418155998US

NON-PROVISIONAL PATENT APPLICATION

of

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for

SUBSURFACE WASTEWATER INFILTRATION SYSTEM

Attorney Docket 11914-0013

536794

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CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Application Serial No. 60/463,383, filed April 16, 2003 and U.S. Application Serial No. 60/475,432, filed June 3, 2003, both of which are expressly incorporated by reference herein.

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to subsurface wastewater infiltration systems and improvements thereto. More particularly, this invention relates to an improved method for dispersing wastewater effluent into the soil for final treatment and disposal.

Subsurface wastewater infiltration systems are the most commonly used systems for the treatment and dispersal of onsite wastewater. Infiltrative surfaces are located in permeable, unsaturated natural soil or imported fill material so wastewater can percolate through the underlying soil to the ground water. As the wastewater infiltrates and percolates through the soil, it is treated through a variety of physical, chemical, and biochemical processes and reactions.

Many different designs and configurations are used, but most all incorporate soil infiltrative surfaces that are located in buried excavations. The primary infiltrative surface is the bottom of the excavation, but the sidewalls also may be used for infiltration. Perforated pipe is typically used to distribute the wastewater over the infiltrative surface. A porous medium, typically gravel or crushed rock, is placed in the excavation below and around the distribution piping to support the pipe and spread the localized flow from the distribution pipes across the excavation cavity. Other gravelless or aggregate-free system components may be substituted. The porous medium maintains the structure of the excavation, exposes the applied wastewater to more infiltrative surface, and provides storage space for the wastewater within its void fractions or interstitial spaces during peak flows.

The method and pattern of wastewater distribution in a subsurface infiltration system are important design elements. Uniform distribution aids in maintaining unsaturated flow below the infiltrative surface, which results in wastewater retention times in the soil that are sufficiently long to effect treatment and promote subsoil reaeration. Uniform distribution also results in more complete utilization of the

infiltrative surface. Gravity flow and pressure dosing are the two most commonly used distribution methods.

Gravity flow discharges effluent directly to the infiltrative surface as incoming wastewater displaces it from its source. Typically, gravity discharges are too low to flow throughout the entire distribution network causing unequal and localized overloading of the infiltrative surface with concomitant poor treatment and soil clogging. Pressure dosing utilizes pumps or siphons to periodically dose a predetermined volume of wastewater through perforated piping over the infiltrative surface. Pressure dosing provides a much more uniform distribution of wastewater and provides periods between doses to allow the subsoil to drain and reaerate before the next dose. As a result, dosed-flow systems reduce the rate of soil clogging, more effectively maintain unsaturated conditions in the subsoil, and provide a means to manage wastewater effluent applications to the infiltration system.

Drip distribution, which was derived from drip irrigation technology, has recently been introduced as a method of pressure dosing. It is a method of pressure distribution capable of delivering small, precise volumes of wastewater effluent to the infiltrative surface. It is the most efficient of the distribution methods. Driplines are typically installed in shallow, narrow trenches without any porous medium so that the emitter orifices are in direct contact with the soil. Because there is no porous medium or storage volume in the dripline trench, wastewater flows can cause localized overloading and allow untreated wastewater to surface, threatening public health and water resources.

Accordingly, a need exists for a subsurface wastewater infiltration system that combines the storage capacity of a porous medium with the efficiency of the drip distribution method.

The present invention is a subsurface wastewater infiltration system designed to provide effective treatment and disposal of wastewater into an infiltrative surface by providing wastewater storage capacity and uniform, efficient distribution as provided by driplines. The wastewater infiltration system preferably follows a pretreatment system consisting of a septic tank or other advanced treatment system which provides primary treatment of the wastewater. A pumping station consisting of a storage tank with pressure pumps preferably follows the primary treatment system and provides the pressure required to operate the system. A wastewater filter is installed on the pumping station discharge line to remove any particles large enough to plug the dripline emitters.

Wastewater is periodically dosed by the pumping station to a solid dosing pipe which transports the wastewater from the station to the subsurface infiltrative area. The dosing pipe is connected to a supply manifold consisting of a solid pipe with connections for driplines at the desired spacing interval. The driplines are connected to the supply manifold using the dripline manufacturer's recommended fittings and connections.

Shallow subsurface infiltrative trenches are laid out and excavated in accordance with the specific site conditions, local regulations or dripline manufacturer's requirements. The excavated trench is partially filled with a porous medium such as sand, gravel, stone, or other man-made materials. The dripline is placed on or within the porous medium and may be covered with a geotextile or filter material to prevent migration of backfill soils into the porous medium. The trench is then backfilled and wastewater is applied to the dripline. Wastewater is uniformly distributed from the drip line emitters into the porous medium, and then flows through the medium to the infiltrative surface. The porous medium provides more available infiltrative surface area along the bottom and sidewalls of the trench and water storage capacity within the interstitial spaces of the medium. Access points are illustratively provided in the trench to the ground surface to permit maintenance or removal of the dripline, inspection of the infiltrative surface for clogging or root intrusion, or to allow the entry of air to provide aerobic conditions within the storage area and along the infiltrative surface.

In another embodiment of this invention, the dripline is placed inside a perforated pipe assembly and the dripline and perforated pipe are placed in the shallow excavation without placement of any porous medium. The perforated pipe may be covered with a geotextile material or fabric sock to prevent the migration of certain types of soils into the interior of the pipe. The shallow excavation is backfilled and the wastewater is uniformly applied to the infiltrative surface by flow from the dripline emitters moving through the storage area and through the walls of the perforated pipe. Alternatively, the dripline is laid in the shallow excavation and covered with a half-pipe or other type of chamber which prevents direct contact with the overlying soil and provides storage capacity under the chamber. In this embodiment, wastewater flows from the dripline emitter directly onto the infiltrative surface, with storage area available from the top of the dripline to the bottom side of the half-pipe or chamber. The perforated pipe, half-pipe or chamber is illustratively sealed at both ends with an entry and exit for the dripline in order to prevent soils migration into the storage area. The seal is designed so that the

dripline can be easily removed for maintenance or replacement in case of clogging or failure of the pipe. Access points are provided in the perforated pipe, half-pipe or chamber to the ground surface to permit maintenance or removal of the dripline, inspection of the interior of the infiltrative surface for clogging or root intrusion, or to allow the entry of air to provide aerobic conditions within the storage area and along the infiltrative surface.

Dripline emitters may be either pressure compensating or turbulent flow depending on the specific site terrain, local regulations or dripline manufacturer's recommendations. Pressure compensating emitters allow a more even distribution of wastewater as they discharge a nearly constant rate over a wide range of in-line pressures. Pressure regulators may be required for turbulent flow emitters in accordance with site conditions, local regulations or dripline manufacturer's recommendations.

Dripline systems may be provided with air and vacuum release valves at system high points to allow draining of the driplines between doses without creating a vacuum in the network. The vacuum could cause soil particles to be aspirated into the dripline emitter orifices.

A dripline return manifold may be installed at the opposite end of the driplines from the supply manifold and may consist of a solid pipe with connections for the driplines at similar intervals as the supply manifold. Alternatively, the driplines could loop and return back to the supply manifold location. The dripline return manifold may be connected to a solid flush pipe which connects the driplines back to the primary treatment device. A valve may be installed in flush line and may be periodically opened during a pressure dosing cycle to allow any accumulated sediment or solids to be flushed from the driplines back to the treatment system. Alternatively, automatic flush valves could be provided at the end of each dripline to allow flushing of the driplines onto the infiltrative surface as permitted by local regulations or the dripline manufacturer's recommendations.

The present invention allows the efficient, uniform distribution of dripline emitters while proving the required storage capacity to prevent localized hydraulic overloading of the soil during periods of high wastewater flows. Uniform distribution aids in maintaining unsaturated flow below the infiltrative surface, which results in wastewater retention times in the soil that are sufficiently long to effect treatment and promote subsoil reaeration. Uniform distribution also results in more complete

utilization of the infiltrative surface.

The present invention also permits the subsurface infiltrative area to be smaller than a typical drip distribution system since storage capacity is provided to account for peak loading conditions, while conventional drip distribution areas must be sized to handle peak hydraulic loading rates without surfacing or allowing anaerobic conditions to develop in the soil.

The present invention further allows the removal and replacement of the dripline without excavating in the case of clogging or for maintenance purposes, significantly reducing the long term operating cost of the system.

The present invention still further allows the inspection of the infiltrative surface and dripline through the access locations without excavating the dripline, providing better system operation and maintenance as well as determining accurate hydraulic loading rates without flooding the infiltrative surface.

In addition, the present invention permits air to be introduced directly to the infiltrative surface through the access openings to maintain aerobic conditions and reduce the rate of soil clogging, and providing better treatment of the wastewater prior to entering the ground water.

Additional features of the invention are set forth in the description that follows, and will become apparent to those skilled in the art upon reviewing the drawings in connection with the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view of an illustrated embodiment of a subsurface drip irrigation wastewater disposal system according to the present invention;

Figs. 2a and 2b are plan views of a dripline installed within a trench, outer pipe, half-pipe or chamber according to the present invention;

Figs. 3a – 3d are sectional view a dripline installed within a trench within a porous medium, an outer pipe, a half-pipe and a chamber, respectively;

Figs. 4a is a side views illustrating a dripline installed within a trench within a porous medium according to the present invention; and

Fig. 4b is a side views illustrating a dripline installed within a trench within a structure defining an open area around the dripline.

DETAILED DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an illustrated embodiment of a subsurface wastewater infiltration system of the present invention. Wastewater generated in the building 10 flows through pipe 20 to a primary treatment device 30 such as a septic tank. Effluent from the septic tank flows through pipe 20 to a secondary treatment device 40. Typical secondary treatment devices could include aerobic treatment units, attached growth media filters, constructed wetlands, or other devices which reduce biochemical oxygen demand and total suspended solids to acceptable levels for disposal. Examples of possible secondary treatment devices 40 are illustrated in U.S. Application Serial No. 10/348,497, U.S. Patent No. 6,616,832, and U.S. Patent No. 6,132,599, all of which are expressly incorporated by reference herein.

Effluent from the secondary treatment device is pumped into pipe 50 and is transported to a supply header 60 to which driplines 80 are connected. Effluent flows into the driplines and is emitted from the orifices 81 (shown in Figs. 2a and 2b) along the length of the dripline 80. Effluent from the driplines 80 flows into the trench, perforated storage pipe, half pipe, or chamber 100 and infiltrates into the soil 75. After the dosing cycle is complete the pumps in the secondary treatment device shut off and the pressure in the supply header is reduced. An air valve 70 opens allowing air into the supply manifold, permitting the driplines to drain. On a scheduled basis, flush valve 120 is opened during a dosing cycle allowing effluent to flow through flush header 110, into pipe 130 and back to the inlet side of the primary treatment device to prevent solids buildup in the driplines.

Fig. 2a illustrates a first embodiment of the dripline 80 installed within trench 100, passing through the trench end barrier 85, passing below an access port riser including a pipe 96 extended to the surface to allow inspection and air recirculation within the trench. A removable cap 95 is coupled to the pipe 96. Fig. 4a further illustrates this embodiment in which the dripline 80 installed within the porous medium 140, the medium which may be covered by a geotextile of filter material 150 to prevent the migration of soil fines into the porous medium, passing through the trench end barrier 85, passing below an access port riser including a pipe 96 extended to the surface 76 with a removable cap 95 to allow inspection and air recirculation within the trench 100.

In another embodiment illustrated in Fig. 2b, the dripline 80 is installed in a perforated storage pipe, half pipe or chamber 110. The dripline 80 passes through an end

cap 85 and through an access port 90 consisting of a tee, saddle, or other open chamber, a pipe 96 extended to the surface with a removable cap 95 thereon to allow inspection and air recirculation within the storage area. Fig. 4b further illustrates this embodiment provides a side view of the perforated storage pipe, half pipe or chamber 110, passing through end cap 86 and through access port 90, with access port risers 96 connecting to the cap 95 at or just below the ground surface 76.

Figs. 3a-3d provide end views of four illustrated embodiments of the present invention. In Fig. 3a, the dripline 80 is installed within a porous medium 140, the medium 140 which may be covered by a geotextile of filter material 150 to prevent the migration of soil fines into the porous medium 140.

Shallow subsurface infiltrative trenches 100 are laid out and excavated in accordance with the specific site conditions, local regulations or dripline manufacturer's requirements. The excavated trench 100 includes a bottom surface 125 and side walls 135. Trench 100 is first partially filled with a porous medium 140 such as sand, gravel, stone, or other man-made materials. A dripline 80 is placed on or within the porous medium 140 and may be covered with a geotextile or filter material 150 to prevent migration of backfill soils into the porous medium 140. The trench 100 is then backfilled with soil 77 and wastewater is applied to the dripline 80 as discussed above. Wastewater is uniformly distributed from the drip line emitters 81 into the porous medium 140, and then flows through the medium 140 to the infiltrative surface of the soil 75. The porous medium 140 provides more available infiltrative surface area along the bottom 125 and side walls 135 of the trench 100 and water storage capacity within the interstitial spaces of the medium 140. Access points are illustrative provided by pipes 96 in the trench 100 which extend to the ground surface 76 to permit maintenance or removal of the dripline 80, inspection of the infiltrative surface for clogging or root intrusion, or to allow the entry of air to provide aerobic conditions within the storage area and along the infiltrative surface.

In another embodiment illustrated in Fig. 3b, the dripline 80 is placed inside a perforated pipe assembly 120 and the dripline 80 and perforated pipe 120 are placed in the trench 100 without placement of any porous medium 140. The perforated pipe 120 may be covered with a geotextile material or fabric sock (not shown) to prevent the migration of certain types of soils into the interior of the pipe 120. The shallow excavation trench 100 is backfilled with soil 77 and the wastewater is uniformly applied

to the infiltrative surface by flow from the dripline emitters moving through the storage area and through the walls of the perforated pipe 120.

Alternatively, the dripline 80 is laid in the trench 100 and covered with a half-pipe 130 shown in Fig. 3c or other type of chamber 145 illustratively shown in Fig. 3d which prevents direct contact between the dripline 80 and the overlying soil 77 and provides storage capacity under the chamber 130, 145. In this embodiment, wastewater flows from the dripline emitters 81 directly onto the infiltrative surface, with storage area available from the top of the dripline 80 to the bottom side of the half-pipe 130 or chamber 145. The perforated pipe 120, half-pipe 130 or chamber 145 are illustrative structures which form an open area 155 around the dripline 80. The perforated pipe 120, half-pipe 130 or chamber 145 is illustratively sealed at both ends with an entry and exit cap 86 or other seal for the dripline 80 in order to prevent soils migration into the storage area. The sealed is designed so that the dripline 80 can be easily removed for maintenance or replacement in case of clogging or failure of the pipe. Access points 96 are provided in the perforated pipe 120, half-pipe 130 or chamber 145 to the ground surface 76 to permit maintenance or removal of the dripline 80, inspection of the interior of the infiltrative surface for clogging or root intrusion, or to allow the entry of air to provide aerobic conditions within the storage area and along the infiltrative surface.

The medium 150, or open area 155 provided by the perforated pipe 120, half-pipe 130 or chamber 145 is provided at or below the ground surface 76, allowing the dripline 80 to be installed at a shallow depth in the uppermost soil layer. This uppermost soil layer contains the greatest number of aerobic bacteria for further treatment of the effluent wastewater and contains the greatest number of plant roots allowing high levels of evapotranspiration.

While the invention set forth above and shown in the drawings is described in reference to certain illustrated embodiments, those skilled in the art will recognize that various modifications can be made to the system disclosed above without departing from the spirit and scope of the invention as set forth in the claims attached hereto. For example, materials other than a porous medium, perforated pipe, half pipe or chamber could be used to provide an open area or storage space around the dripline while buried below the surface of the earth, or different methods can be used to provide access to the dripline from the ground surface for maintenance, inspection or replacement, and provide air to the infiltrative surface.